Tulare Irrigation District

SB 7x-7

Agricultural Water Measurement Master Plan

(Updated December 2015)

Tulare Irrigation District Background

The Tulare Irrigation District (District) was organized on September 21, 1889 as one of the very early irrigation districts in California. For several decades the District operated to deliver surface water supplies from its Kaweah River water rights to landowners and farmers within the District. In 1950 the District signed a contract with the United States Bureau of Reclamation for 30,000 acre-feet of Class 1 and 141,000 of Class 2 water from the Friant Unit of the Central Valley Project. The District averages approximately 180,000 acre-feet of surface water diversions to District landowners in their requirement to meet irrigation demand on approximately 67,202 acres of irrigated agriculture. The District serves approximately 230 family farms with irrigation water.

To meet the irrigation demands of landowners, the District utilizes approximately 300 miles of earthen canals and approximately 30 miles of pipelines. The District also operates approximately 1,250 acres of groundwater recharge basins. Each landowner within the District receives surface water from the District through an individual farm-gate turnout. The District equips each farm-gate turnout with a Meter Gate, which allows the District to measure the instantaneous flow through each farm-gate turnout, which is utilized to determine the volumetric rate of use and bill based upon the volume of water used.

Water Measurement Background

The District utilizes a network of canals and pipelines to deliver water to each landowner within the District. Along each canal or pipeline are farm-gate turnouts that include a canal gate (referred to in this plan as a Meter Gate), which allows the District to control the delivery of irrigation water and measure the instantaneous rate of delivery to each parcel. When landowners request delivery of irrigation water the District Watermaster determines when the landowner can begin his/her irrigation based upon the supply

and demand of surface water and the capacity of the canal system. Once the Watermaster has determined the start time for the landowner an order is placed with the Ditchtender that monitors the area where the landowner requested irrigation service. The Ditchtender then coordinates with the landowner and the Meter Gate is opened. The date, time and flow is recorded when the irrigation begins. The Ditchtender will then return approximately every 24-hours to take another flow reading at the Meter Gate, and again the date, time and flow are recorded. The Ditchtender will continue to return to the turnout and read the Meter Gate until the landowner indicates that they have completed their irrigation, at which time the Meter Gate is closed and the date and time is recorded.

All information that is taken is recorded on hand-held devices, which is an Apple iPod Touch that has a custom application that is integrated with the District billing software, STORM Water Accounting and Management Software (Billing Software). The information that is collected in the field by Ditchtenders is brought back to the office and uploaded to the Billing Software which calculates the volumetric water use by multiplying the flow rate by the time between readings. Landowners are then billed on a monthly basis for volumetric water usage.

Meter Gate Operation

The District currently utilizes 535 irrigation farm-gate turnouts to deliver water to District landowners. Each of these turnouts includes a typical Meter Gate (ARMCO gate or Waterman C-10 canal gate). A limited number of turnouts are utilized in concert with a low-head lift pump, which pumps water from the canal onto a landowner's field. In many of these circumstances the landowners have installed a propeller meter downstream of the pump to measure instantaneous flow and totalize the amount of water used (in gallons or acre-feet). The majority of Meter Gates used by the District do not have a downstream measuring device and include an upstream and downstream head pressure measurement to calculate the flow through the Meter Gate. Please reference Figure 1 for a typical Meter Gate Installation.

The Meter Gates installed in the District are at the upstream end of a smooth concrete, PVC or corrugated metal pipeline. Stilling wells are installed such that an upstream head (h_1) and downstream head (h_2) can be determined. The difference between the two readings is considered the effective operating head across the gate (often referenced as $\triangle h$). The position of the gate is also determined by measuring the amount

of gate stem that is above the gate hand wheel (minus the zero gate position, which is field marked on the stem of the gate). Discharge or flow (cubic feet per second, cfs) is then obtained by utilizing a rating table that has been determined for each size and style of gate. See Figure 2 for a sample ARMCO Gate Discharge Table that is used to determine flow through a Meter Gates that are installed within the District.

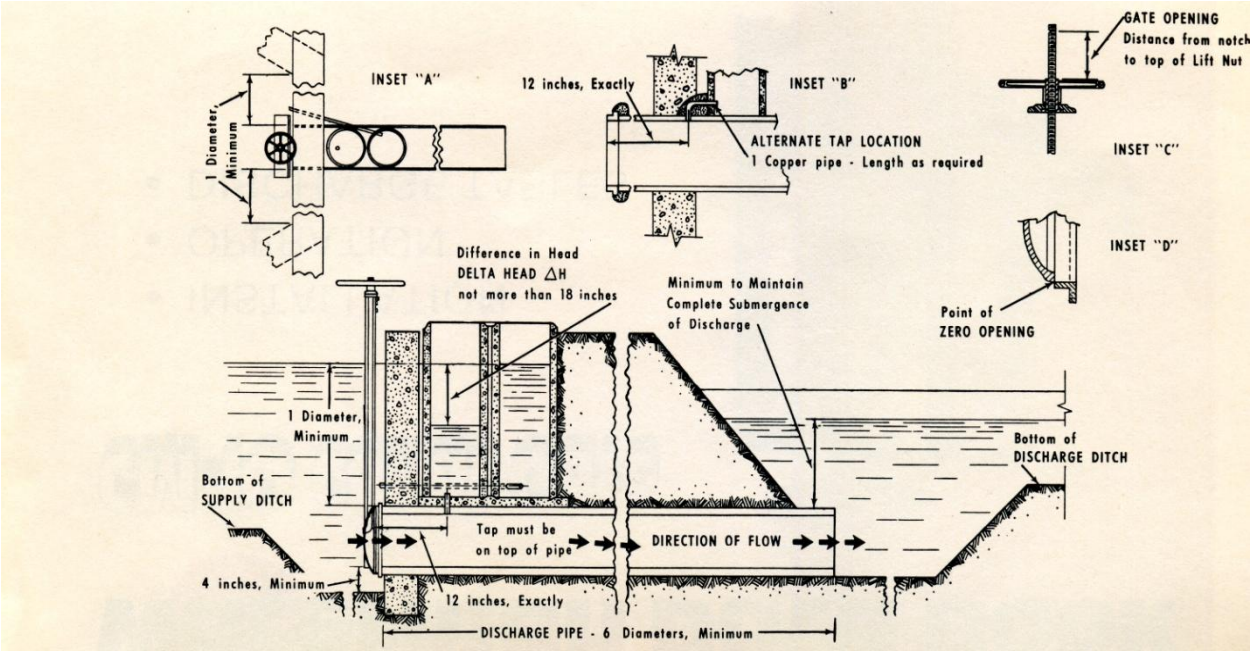

Figure 1. Typical Tulare Irrigation District Meter Gate Installation

TABLE III DISCHARGE DATA 12" ARMCO METERGATE MODEL NO. 101

Head in Inches	Net Gate Opening in Inches														
	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6	7	8	9	10	11	12
	Discharge in Cubic Feet per Second														
1	0.36	0.46	0.53	0.60	0.67	0.74	0.80	0.86	0.93	1.06	1.16	1.27	1.35	1.38	1.40
1 1/4	0.40	0.51	0.58	0.67	0.74	0.82	0.89	0.95	1.03	1.17	1.29	1.41	1.50	1.55	1.57
1 1/2	0.44	0.55	0.63	0.73	0.81	0.89	0.97	1.04	1.12	1.28	1.41	1.54	1.64	1.70	1.73
1 3/4	0.47	0.59	0.68	0.78	0.87	0.95	1.04	1.12	1.21	1.38	1.52	1.66	1.77	1.83	1.86
2	0.50	0.63	0.73	0.83	0.93	1.01	1.10	1.19	1.29	1.47	1.62	1.77	1.89	1.96	1.99
2 1/4	0.53	0.67	0.78	0.88	0.98	1.07	1.16	1.26	1.36	1.55	1.71	1.87	2.00	2.08	2.12
2 1/2	0.56	0.70	0.82	0.92	1.03	1.13	1.22	1.32	1.43	1.63	1.80	1.97	2.11	2.20	2.23
2 3/4	0.59	0.73	0.85	0.96	1.08	1.18	1.28	1.38	1.49	1.70	1.88	2.06	2.21	2.31	2.34
3	0.61	0.76	0.88	1.00	1.12	1.23	1.34	1.44	1.55	1.77	1.96	2.14	2.31	2.41	2.45
3 1/4	0.63	0.79	0.91	1.04	1.16	1.28	1.39	1.50	1.61	1.84	2.04	2.22	2.40	2.50	2.55
3 1/2	0.65	0.82	0.94	1.08	1.20	1.33	1.44	1.56	1.67	1.91	2.12	2.30	2.49	2.59	2.65
3 3/4	0.67	0.84	0.97	1.11	1.23	1.38	1.49	1.61	1.73	1.98	2.19	2.38	2.57	2.68	2.74
4	0.69	0.86	1.00	1.14	1.27	1.42	1.54	1.66	1.79	2.04	2.26	2.46	2.65	2.77	2.83
4 1/4	0.71	0.89	1.03	1.17	1.31	1.46	1.59	1.71	1.85	2.10	2.33	2.54	2.73	2.86	2.92
4 1/2	0.73	0.92	1.06	1.20	1.35	1.50	1.64	1.76	1.90	2.16	2.40	2.62	2.81	2.94	3.01
4 3/4	0.75	0.94	1.09	1.23	1.39	1.54	1.68	1.81	1.95	2.22	2.47	2.69	2.89	3.02	3.10
5	0.77	0.96	1.12	1.26	1.42	1.58	1.72	1.86	2.00	2.28	2.54	2.76	2.96	3.10	3.19
5 1/2	0.80	1.00	1.17	1.32	1.49	1.66	1.80	1.95	2.10	2.39	2.66	2.89	3.10	3.24	3.34
6	0.83	1.04	1.22	1.38	1.56	1.73	1.88	2.04	2.19	2.50	2.78	3.02	3.24	3.38	3.48
6 1/2	0.86	1.08	1.27	1.44	1.62	1.80	1.96	2.12	2.28	2.60	2.89	3.14	3.37	3.52	3.62
7	0.89	1.12	1.31	1.49	1.68	1.87	2.04	2.20	2.36	2.70	3.00	3.26	3.50	3.65	3.76
7 1/2	0.92	1.16	1.35	1.54	1.74	1.93	2.11	2.28	2.44	2.79	3.10	3.38	3.62	3.78	3.89
8	0.95	1.20	1.39	1.59	1.80	1.99	2.18	2.35	2.52	2.88	3.20	3.49	3.74	3.90	4.02
8 1/2	0.98	1.24	1.43	1.64	1.86	2.05	2.25	2.42	2.60	2.97	3.30	3.60	3.85	4.02	4.14
9	1.01	1.27	1.47	1.69	1.91	2.11	2.31	2.49	2.68	3.06	3.40	3.70	3.96	4.14	4.26
9 1/2	1.04	1.30	1.51	1.74	1.96	2.17	2.37	2.56	2.75	3.14	3.50	3.80	4.07	4.25	4.38
10	1.07	1.33	1.55	1.79	2.01	2.23	2.43	2.63	2.82	3.22	3.59	3.90	4.18	4.36	4.49
11	1.12	1.39	1.63	1.87	2.11	2.34	2.55	2.76	2.96	3.38	3.76	4.09	4.38	4.57	4.70
12	1.17	1.45	1.70	1.95	2.21	2.44	2.67	2.88	3.10	3.53	3.93	4.27	4.58	4.78	4.92
13	1.22	1.51	1.77	2.03	2.30	2.54	2.78	3.00	3.22	3.68	4.09	4.45	4.77	4.98	5.12
14	1.27	1.57	1.84	2.11	2.38	2.64	2.88	3.11	3.34	3.81	4.24	4.61	4.95	5.17	5.31
15	1.32	1.62	1.90	2.19	2.46	2.73	2.98	3.22	3.46	3.94	4.39	4.77	5.12	5.35	5.49
16	1.36	1.67	1.96	2.26	2.54	2.82	3.08	3.33	3.57	4.07	4.53	4.93	5.29	5.52	5.67
17	1.40	1.72	2.02	2.33	2.62	2.91	3.17	3.43	3.68	4.20	4.67	5.08	5.45	5.69	5.85
18	1.44	1.77	2.08	2.39	2.70	2.99	3.26	3.53	3.79	4.33	4.81	5.23	5.61	5.85	6.02

Figure 2. Typical Waterman Gate Discharge Table

Example:

The Ditchtender reads the upstream head at 12" and the downstream head at 16". This means that the effective operating head across the gate or the $\triangle h$ is 4". The Ditchtender also reads the gate position by tape measuring the distance from the top of the hand wheel to the zero-mark at 6". The Meter Gate is an 12" ARMCO Model No. 101 canal gate. Utilizing the chart provided in Figure 2, the instantaneous flow is 1.79 CFS. If the landowner ran for 24 hours, the District would record a total volumetric usage of 3.55 acre-feet and the landowner would be billed based on this value. A sample bill is included in Appendix C (Section 10) of the 2015 Agricultural Water Management Plan.

Method of Certification

Since the adoption of the 2012 Agricultural Water Management by the District, the State of California experienced consecutive years of drought conditions. The District subsequently did not delivery any irrigation water supplies from late 2012 through 2014. Without the ability to deliver water the original meter certification plan was unable to be accomplished. However, during that period experts within the water measurement profession have conducted studies and the findings have allowed the District to modify the approach that will be taken by the District with the adoption of the 2015 Agricultural Water Management Plan.

Existing Meter Gate Certification

In September 2014 the Irrigation Training and Research Center located at the California Polytechnic State University, San Luis Obispo (ITRC) published a report called the "Practical Guide for Metergates" which is attached to this report as Attachment A. This report was a summary of finding for tests that were conducted on typical meter gates that are utilized within the District. The ITRC tested various Armco-type meter gates to reaffirm previous meter accuracy estimates. Gates were installed within the ITRC calibration facility and simulated the flow pattern that is typically experienced in canal operations (perpendicular to the main supply channel flow).

The study found that meter gates that are installed and operated in a specific manner could yield a high level of accuracy of +/-5% given specific conditions were present. The conditions required by Cal Poly to achieve +/- 5% accuracy and those which the District proposes to verify are:

- Gate operates between 20% and 75% of the gate opening

- Upstream submergence of greater than 50% of the gate diameter
- Stilling wells are installed 4" to 12" downstream of the face of the meter gate

The District also intends to verify that the following conditions are established to ensure a consistent and accurate reading during water measurement operations:

- The "zero" gate opening must be marked on the gate stem
- Stilling wells are sized between 6" and 8" in diameter to dampen static water readings
- Water levels upstream and downstream are read based upon a fixed benchmark

The District Engineer will train key staff to inspect gates along each canal and certify each of the components listed above. Records of each gate inspection shall be retained and any failure to meet the above criteria shall be noted.

Meter Field Inspection

The District is in the process of inspecting all 535 farm-gate turnouts to ensure that the installation of each facility conforms to the recommended and accepted practices that yield the highest accuracy possible. The District is utilizing the criteria established by the Cal Poly ITRC, *Practical Guide for Metergates* and outlined above. The results of the inspections will be provided in the Meter Certification Report.

Critical features to would include, but are not limited to:

- Gate operates between 20% and 75% of the gate opening
- Upstream submergence of greater than 50% of the gate diameter
- Stilling wells are installed 4" to 12" downstream of the face of the meter gate
- The "zero" gate opening must be marked on the gate stem
- Stilling wells are sized between 6" and 8" in diameter to dampen static water readings
- Water levels upstream and downstream are read based upon a fixed benchmark

Sample Size and Determination

The District currently utilizes 535 irrigation farm gate turnouts, which include the installation and use of a Meter Gates to deliver water to landowners. To meet the standards for certification under the field inspection alternative, the District is prepared to inspect all 535 farm-gate turnouts to ensure certification.

Staff

The certification process shall be overseen by the District Engineer, Aaron Fukuda who is a Professional Engineer (P.E. 65295) in the State of California. The District Engineer shall also be assisted by the District Engineering Technician and other Ditchtenders who have experience in water measurement and shall be trained by the District Engineer in the verification process. The final Meter Certification Report shall be prepared and certified by the District Engineer.

Schedule

Due to the recent water year conditions, the District has been unable to implement the Initial Certification of existing water measurement devices within the District. Accordingly, the District proposes to conduct the Initial Certification process starting January 2016 and continuing until all gates have been inspected. The following schedule is provided as a best attempt to outline the process the District will follow, however as each Task is accomplished the Schedule along with the Budget may be modified to reflect findings and accomplishments at each Task:

Task No.	Activity	Date
1	Initial Certification (Field Inspection/Field Testing)	Start Jan. 2016
2	Meter Certification Report Preparation	Jan 2017 – March 2017
3	Meter Certification Report – Final	May 2017 (Board Mtg.)
4	Phase 1 - Meter Corrective Action	Jun 2017 – Dec.2017
5	Optional – Second Round Certification (As Required)	Jan. 2018 – April 2018
6	Phase 2 – Meter Corrective Action	Sept. 2018 – Dec 2018
7	Phase 3 – Meter Corrective Action	Jan. 2019 – March 2019
8	Phase 4 – Meter Corrective Action	April 2019 – June 2019
9	Phase 5 – Meter Corrective Action	Sept. 2019 – Nov 2019

Variability in the schedule may come at the following Tasks:

- If the Meter Certification Report (Task 3) finds that the existing meters are within a +/-12% accuracy range the Certification Process will conclude that the District has met all regulations and will continue to measure and bill according to volumetric usage.
- If the Meter Certification Report (Task 3) finds that the existing meters do not read within a +/-12% accuracy range the total number of turnouts that reads outside of this accuracy shall be determined. If more than 25% of the turnouts read greater than a +/-12% accuracy the District shall conduct a second round of Meter Certifications (Task 5).
- Any of the tasks may be impacted by weather and/or surface water deliveries that will make access to inspection impossible.

Results (Meter Certification Report)

Once the District has completed the testing or inspection of the Meter Gates identified by the Plan a Meter Certification Report will be created. The report will be prepared by the District Engineer and the District Engineering Technician, with final approval and certification coming from the District Board of Directors and the District Engineer respectively. Included in the Report will be the following information:

- Description of Certification Process (including devices and field testing conducted)
- Results of the Certification Process
- Discussion of Future Certification Requirements
- Recommended Meter Modifications (Device Correction Plan)
- Schedule for Meter Modifications
- Budget for Meter Modifications

Device Correction Plan

The Device Correction Plan will be established using the results discovered from the Initial Certification (Task 1). During the certification the District will determine the ability of the existing meters to be modified or calibrated to achieve an accuracy of +/-12%. The District will establish a process to adjust existing meters to meet the accuracy requirements set forth.

If it is determined that the existing meters that are utilized to measure irrigation deliveries within the District cannot meet the +/-12% requirement and cannot be modified to achieve such, the District will strive to identify and create a Water Measurement Replacement Program (Replacement Program). The Replacement program will identify the types of measurement devices to be implemented, the schedule for implementation and the cost to carry out the Replacement Program. If this is required Tasks 4, 6, 7, 8, and 9 will involve the replacement of meters rather than the modification of existing meters.

Budget

The District has estimated the maximum cost to reach compliance at approximately $817,000 based upon its current understanding of the law. An Engineers Estimate (Budget) is included below. This maximum budget reflects the conservative assumption that all of the District's 50-plus meters will need either replacement or some form of repair. Based on staff's knowledge of the canal system and associated farm-gate turnout configurations, the certification protocol should result in significantly fewer number of turnouts in need of alteration. The Budget set forth in this document is subject to changed based upon the findings and necessity to perform meter modifications.

Tulare Irrigation District

Meter Certification and Modification Budget

Engineer's Estimate

Task No.	Description	Quantity	Unit	Unit Price	Total
1	**Initial Certification**				
1a	District Engineer	200	Hours	$75	$15,000
1b	Engineering Technician	300	Hours	$35	$10,500
				Subtotal	*$25,500*
2	**Meter Certification Report Preparation**				
2a	District Engineer	75	Hours	$75	$5,625
2b	Engineering Technician	50	Hours	$35	$1,750
				Subtotal	*$7,375*
3	**Meter Certification Report - Final**				

3a	District Engineer	24	Hours	$75	$1,800
3b	Engineering Technician	24	Hours	$35	$840
				Subtotal	*$2,640*
4	**Phase 1 Meter Corrective Action**				
4a	Meter Modification	100	Each	$2,000	$200,000
4b	District Engineer	200	Hours	$75	$15,000
	Engineering Technician	300	Hours	$35	$10,500
				Subtotal	*$225,500*
5	**Optional - Second Round Certification**				
5a	Rubicon FlumeMeter	1	Each	$8,000	$8,000
5b	Rubicon Mounting Brackets	53	Each	$1,000	$53,000
5c	District Engineer	100	Hours	$75	$7,500
5d	Engineering Technician	150	Hours	$35	$5,250
5e	Boom Truck	100	Hours	$20	$2,000
				Subtotal	*$75,750*
6	**Phase 2 Meter Corrective Action**				
6a	Meter Modification	50	Each	$2,000	$100,000
6b	District Engineer	100	Hours	$75	$7,500
6c	Engineering Technician	150	Hours	$35	$5,250
				Subtotal	*$112,750*
7	**Phase 3 Meter Corrective Action**				
7a	Meter Modification	50	Each	$2,000	$100,000
7b	District Engineer	100	Hours	$75	$7,500
7c	Engineering Technician	150	Hours	$35	$5,250
				Subtotal	*$112,750*
8	**Phase 4 Meter Corrective Action**				
8a	Meter Modification	50	Each	$2,000	$100,000
8b	District Engineer	100	Hours	$75	$7,500
8c	Engineering Technician	150	Hours	$35	$5,250
				Subtotal	*$112,750*
9	**Phase 5 Meter Corrective Action**				
9a	Meter Modification	50	Each	$2,000	$100,000
9b	District Engineer	100	Hours	$75	$7,500
9c	Engineering Technician	150	Hours	$35	$5,250
				Subtotal	*$112,750*
10	**2015 Agricultural Water Management Plan**				

10a	District Manager	16	Hours	$115	$1,840
10b	District Engineer	200	Hours	$75	$15,000
10c	District Watermaster	200	Hours	$45	$9,000
10d	Engineering Technician	100	Hours	$35	$3,500
				Subtotal	*$29,340*
				Total	**$817,105**

Financing

The District is currently expecting to utilize its Infrastructure Rehabilitation Reserve Funds and the ability to seek grants from the Department of Water Resources to achieve the requirements of this Plan. As this Plan is being implemented the District Engineer will be providing financial updates to the District Board of Directors including an initial cost/benefit analysis to determine the feasibility of carrying out the Device Correction Plan. If the District is unable to find suitable existing funds, it shall seek other sources of funding as needed.

ATTACHMENT A